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A review on the status and future trends of radiation processing in Iran

S.R. Rafiee, E. Eftekhari-Zadeh*, Y. Gholami

Shar Parto Iranian Company (SPI Co.), Tehran, Iran

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ABSTRACT

A comprehensive review on the status of radiation processing and its future in Iran is presented since 32 years ago up to now to show the development of Iran's irradiation industry. Additionally, annual throughput of treated materials with their types and names are also given and also all of the radiation facilities both in service and under construction as well as the plans and estimations for establishing the new facilities are outlined. Our investigations show that the trend of radiation processing industry in Iran is growing rapidly.

1. Introduction

Due to the increasing elderly population in Iran, there will be rapid growth in the demand for sterile healthcare products thus the strain on healthcare systems will intensify in the near future (Noroozian, 2012). Nowadays, most of the medical equipment manufacturers in Iran use ethylene oxide (EtO), a very poisonous, carcinogenic, and explosive gas in order to sterile their products. Like many other countries, Iran is being planned to phase out EtO sterilization as a result of Rotterdam Convention (1998) and Montreal Protocol (1987). The best alternative for this method is therefore radiation sterilization due to its prominent features (Woods and Pikaev, 1993). The advantages of radiation sterilization are that there is no residue after sterilization process, the process is simple, fast, and easy to control (only exposure time or dose needs to be controlled), radiation has high penetrating power, the rise in the temperature of the irradiated materials is insignificant, and etc. (Trends in Radiation Sterilization of Health Care Products, 2008).

Meanwhile, according to the statistics made by Food and Agriculture Organization of the United Nations (FAO), Iran is a predominantly agricultural country (The Islamic Republic of Iran at a Glance). Iran ranks 3rd on diversity of agricultural products in the world and ranks 1st in fruit production in the Middle East and North Africa (Iran at a glance, 2015). Iran has also certain strategic agricultural products for export such as saffron, pistachios, and date that the limitation of using chemical substances (e.g. Methyl Bromide) for their preservation as a result of Montreal protocol have severely reduced their export. Radiation processing, however, due to its eco-friendly and unique features can play a significant role to increase the export of such agricultural products throughout the world. Consequently, food irradiation is another major market area in Iran for applications of radiation processing.

The spokesman of the Atomic Energy Organization of Iran (AEOI), which is the primary organization responsible for nuclear technology research and development activities in Iran, in a recent press conference stated that AEOI has planned to build up at least 10 multipurpose gamma irradiation plants in the medium and long term programs for radiation sterilization of disposable medical products. He also added that the country needs 5 electron beam accelerators for wastewater treatment and 10 for material modification (Press conference of AEOI, 2016).

2. National standards

In terms of national regulations it is worthwhile to mention that

* Corresponding author. Shar Parto Iranian (SPI Co.), Central office, Unit 5 East, 5th Floor, No. 6, 1st Alley, Parandeh District, Jalal Al-e-Ahmad Highway, Tehran, Iran.
E-mail address: eftekharizadeh@gammaspi.com (E. Eftekhari-Zadeh).

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the Iranian National Standards Organization (INSO) and Institute of Standards and Industrial Research of Iran (ISIRI) have issued several standards with regard to the radiation processing (also some others are being published) based on ISO, ASTM, and CODEX international standards (Iranian National Standards Organization, Institute of Standards & Industrial Research of Iran).

- INSO_ 6946-1: Sterilization of health care products_ Radiation_ Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices
- ISIRI_ 6946-3: Sterilization of health care products– Radiation– Part 3: Guidance on dosimetric aspects
- ISIRI_8033: Irradiation facilities used for the treatment of foods_ Code of practice for operation
- ISIRI_11333: Irradiation of pre-packaged processed meat and poultry products to control pathogens and other microorganisms – Code of practice
- INSO_16066: Food irradiation — Requirements for the development, validation and routine control of the process of irradiation using ionizing radiation for the treatment of food.
- ISIRI_3102: Code of practice for irradiation of spices.

In the present study, with the aforementioned background, after briefly reviewing the current irradiation facilities in Iran, the new gamma irradiation facility- SGIF- will be introduced thoroughly.

3. Irradiation facilities in Iran

Facilities that are already operating fully:

3.1. Gamma Irradiation Center (GIC)

The history of radiation processing in Iran dates back to the establishment of GIC, IR-136, by AEOI in 1985 (Sohrabpour, 1990). Earlier applications of gamma rays in Iran were just for research purposes in the areas of sprout inhibition of root crops (Sekhavat, Zare, Kudva, Chopra, & Sharitpanahi, 1978) and wood-plastic composites (Gouloubandi, 1982).

IR-136 is of AECL (Nordion) design with the initial activity about 210 kCi. Each tote box of this gamma irradiation plant has the dimensions 45 × 45 × 45 cm. GIC was positioned in the north western part of Tehran and was built next to the buildings of the AEOI in an area of 10000 m^2 of land space (see Fig. 1).

Primary objectives of the GIC were for radiation processing of disposable medical supplies, conducting research and development programs in the fields of microbiology, polymer science, high dose dosimetry, and training specialists in the field of radiation technology. However, soon after the operation, two more functions including food irradiation as well as environmental measurement, were added to the main objectives of the GIC. GIC is equipped with different research laboratories including polymer, microbiology, dosimetry, food irradiation, and also environment. Some of the research activities of this center are mentioned in the references (Sharifzadeh and Sohrabpour, 1993; Zare, Sayhoon, & Maghsoudi, 1993; Razavia, Dadbinb, & Frounchia, 2014; Shawranga, Mansouria, Sadeghib, & Ziaiea, 2011; Arjmand et al., 2014; Danaei, Sheikh, & Afshar Taromi, 2005; Sheikh and Afshar Taromi, 1995; Pourahmad and Pakravan, 1997; Javanmard, Rokni, Bokaie, Shahhosseini, 2006). There are also lots of research papers within the scientific Journal of Nuclear Science and Technology published by AEOI which have used GIC to investigate the effects of gamma irradiation on a variety of products (Journal of Nuclear Science and Technology).

3.2. Yazd Radiation Processing Centre (YRPC)

Established in January 1998, the Yazd Radiation Processing Centre (YRPC) is located 700 km south of Tehran, near the city of Yazd. With the Size of 1700 m^2 and subordination to AEOI, YRPC was one of the modern industrial complexes in Iran at that time. The electron accelerator is an IBA, type Rhodotron TT200, with outputs of 5 MeV and 10 MeV beam lines, both in horizontal and

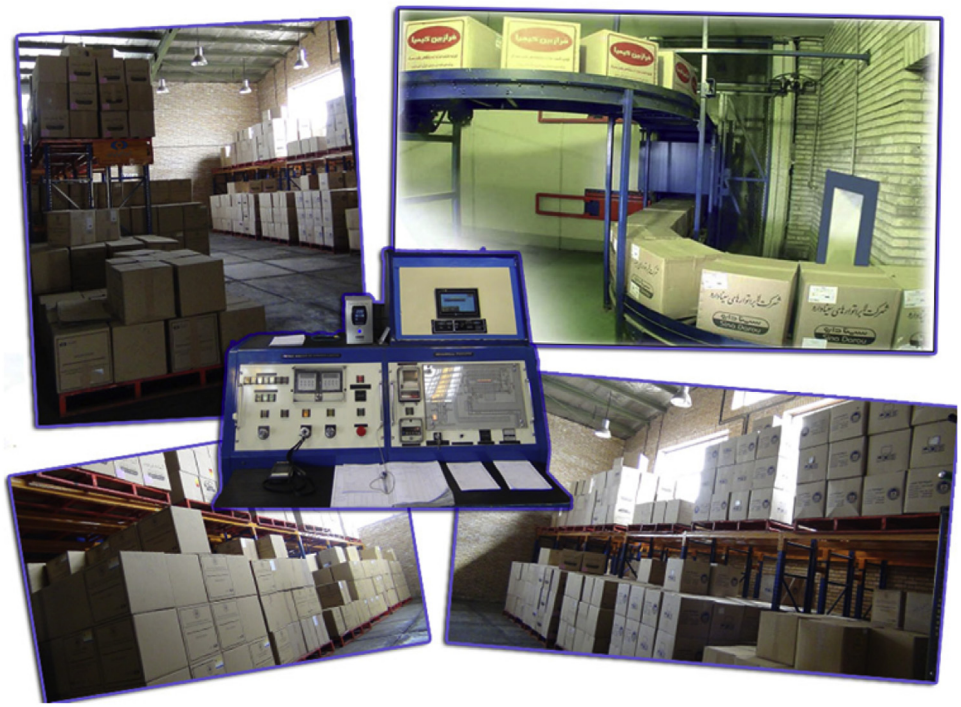

Fig. 1. Gamma irradiation center (GIC).